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# Design of the China Lake NAWS Fuze Test Facility

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# Acknowledgements

- Quality testing of Military Fuses
- Design Build Team
  - Architect: Mosher Drew Watson Ferguson



- Contractor: Soltek Pacific Construction



- Blast Design and ESQD: ABS Consulting



- NAVFAC Engineering Service Center

# Background

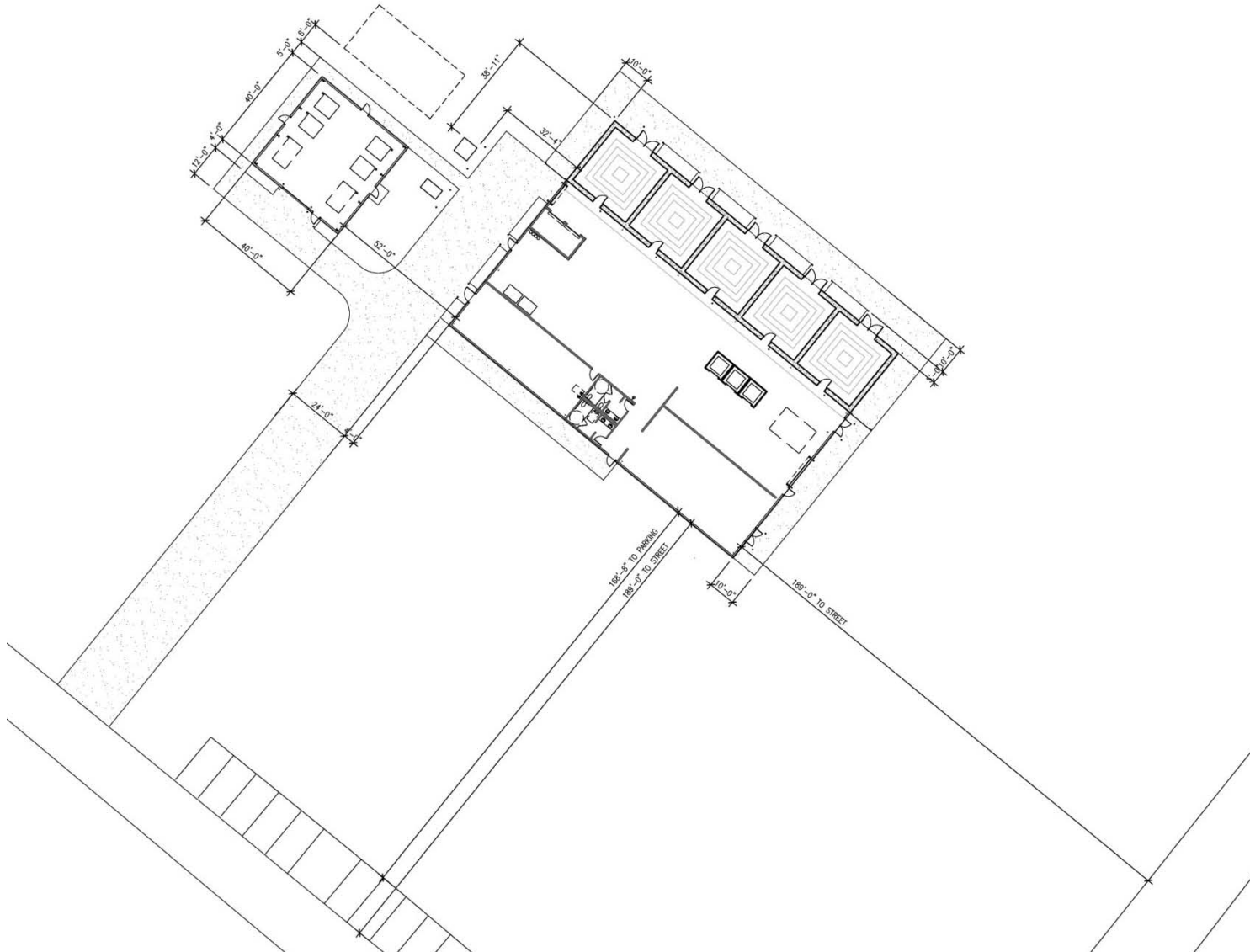
- China Lake NAWS  
– Ridgecrest, CA



# Objectives

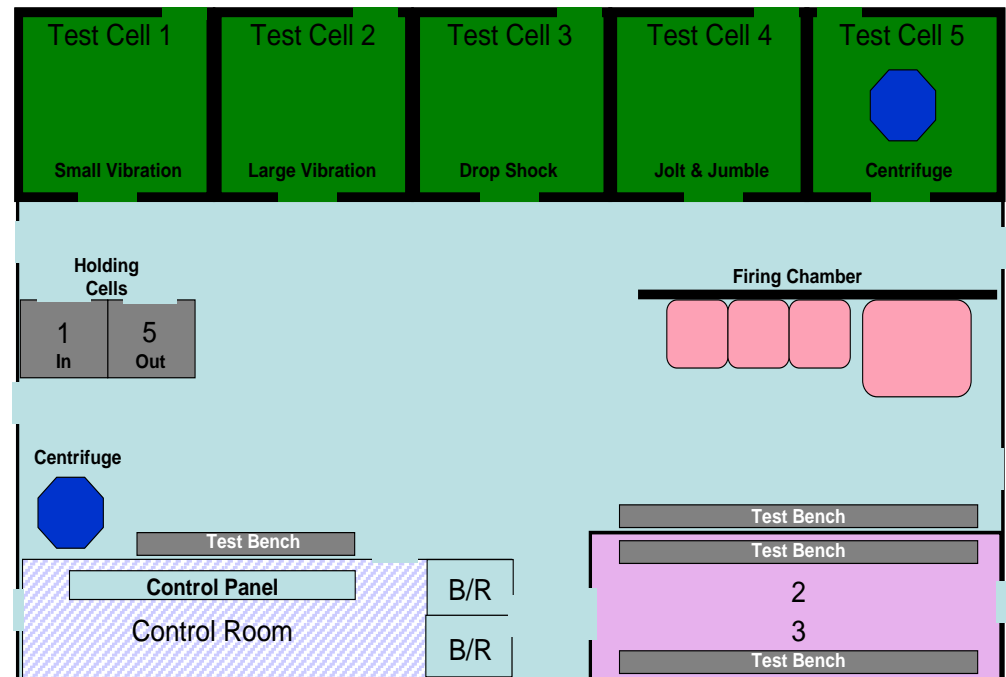
- Design Remote Test Cells to contain effects of accidental detonation
  - Net Explosive Weight =  $10 \text{ lb}_{\text{TNT}}$
  - Minimum Standoff = 10 feet
- Personnel Protection from accidental detonation Remote Test Cell for concurrent operations:
  - Overpressure below 2.3 psi
  - Thermal flux below  $0.3 \text{ cal/cm}^2/\text{sec}$
  - Hazardous fragment energy below  $58 \text{ ft} \cdot \text{lbf}$
- Determine allowable charge weight at required reduced standoffs:
  - 7 feet
  - 5 feet
  - 3 feet

# Facility Layout



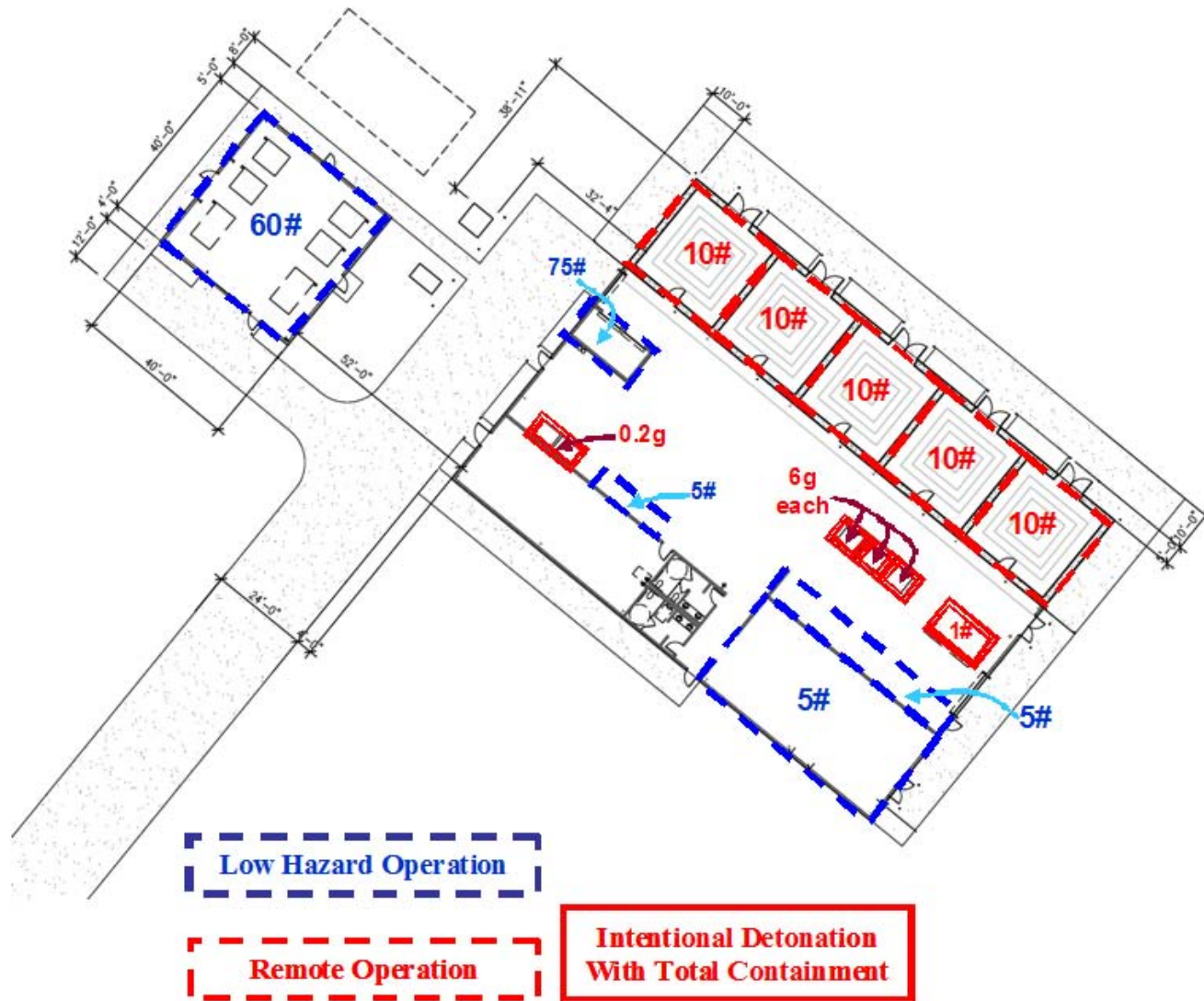
# Fuze Test Building Work Areas

- Fuze Test Building (HD 1.1)
  - Remote Test Cells
  - Holding Cells
  - Test Benches and 2 gram Centrifuge
  - Firing Chamber
  - Control Room



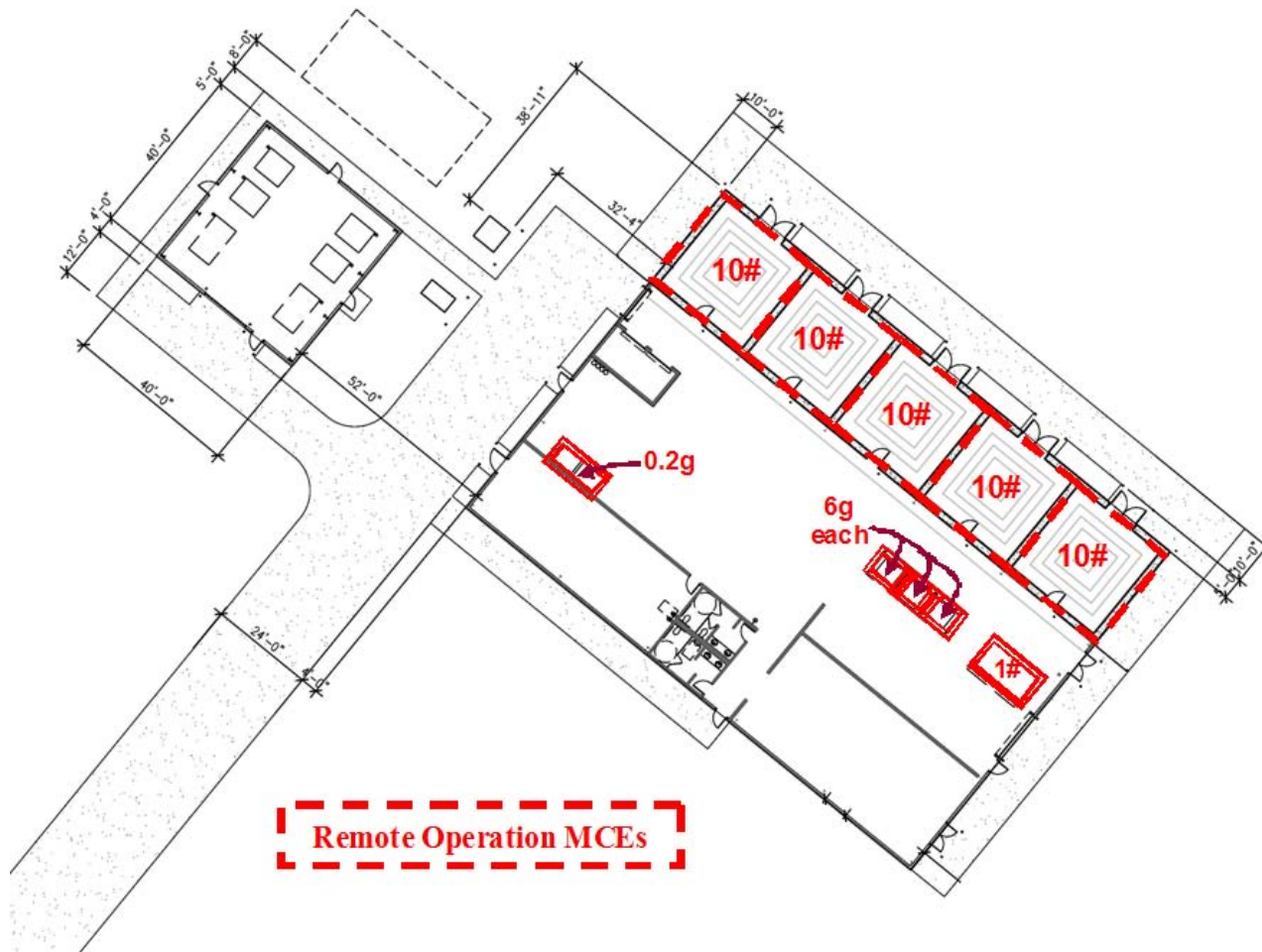


# Explosives Quantities

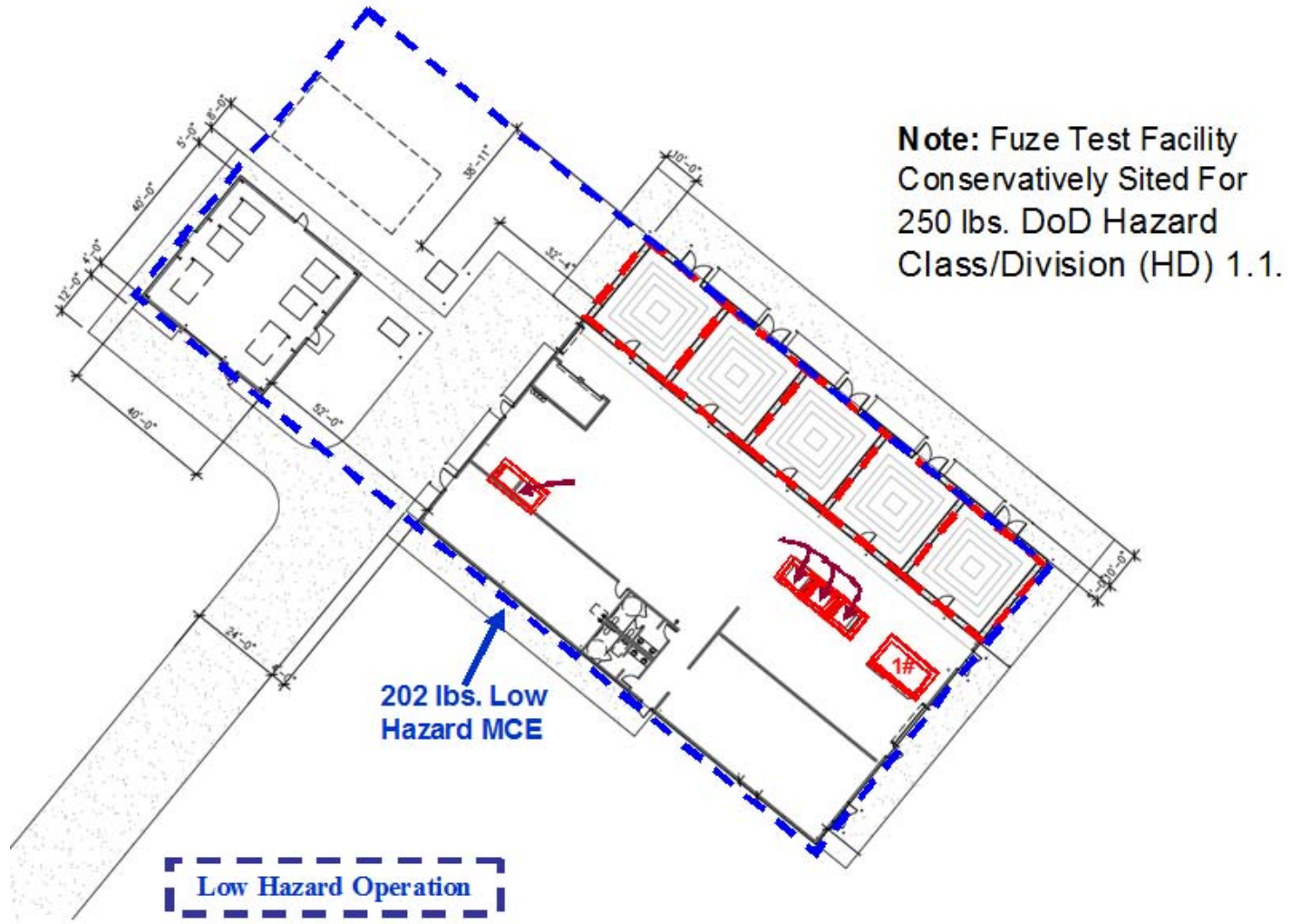




# Remote Operations MCEs

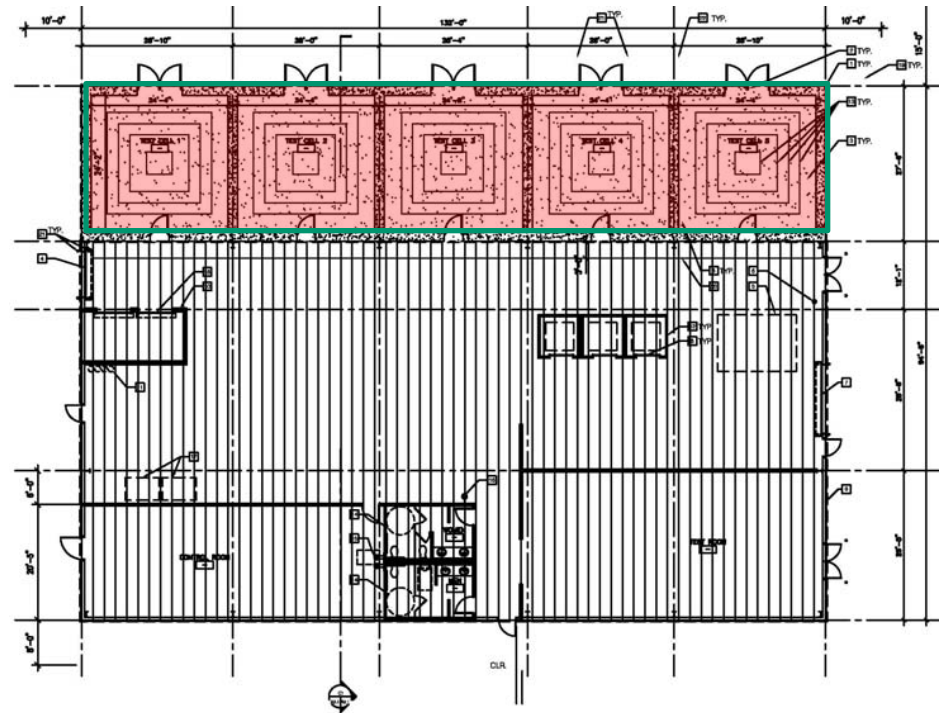


# Low Hazard MCEs



# Remote Test Cell Containment

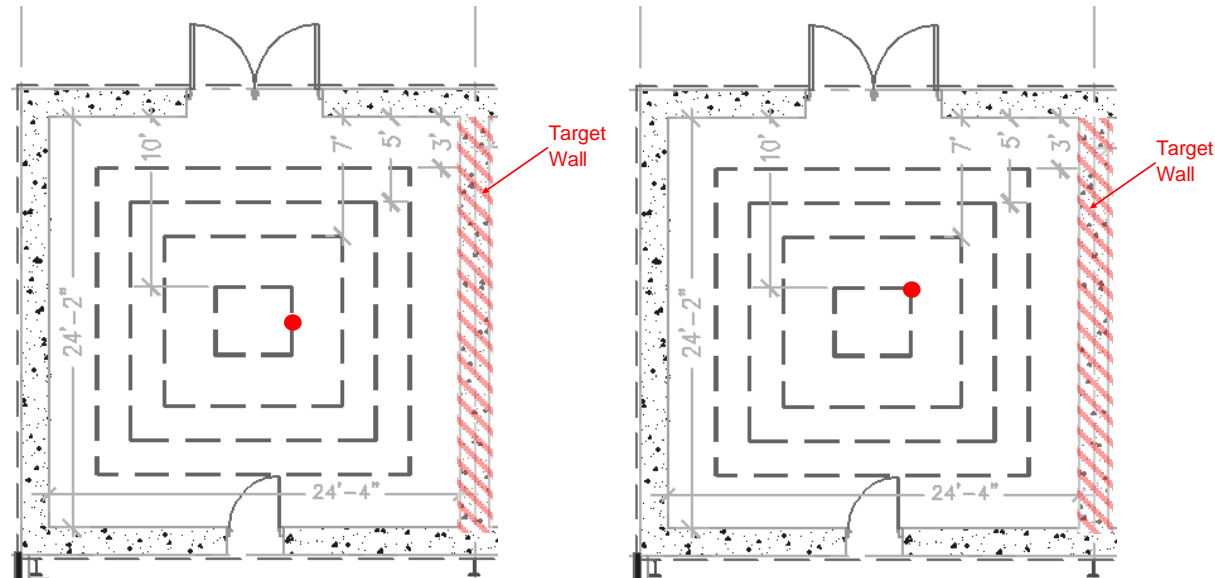
- Design Basis
  - 10 lb<sub>TNT</sub> Containment with Directional Venting
  - Concurrent Operations of Adjacent Bays
  - Personnel Protection Category 1
  - Safety Factor of 1.2
    - Total 12 lb<sub>TNT</sub>
  - TM5-1300, 1990 Rev.



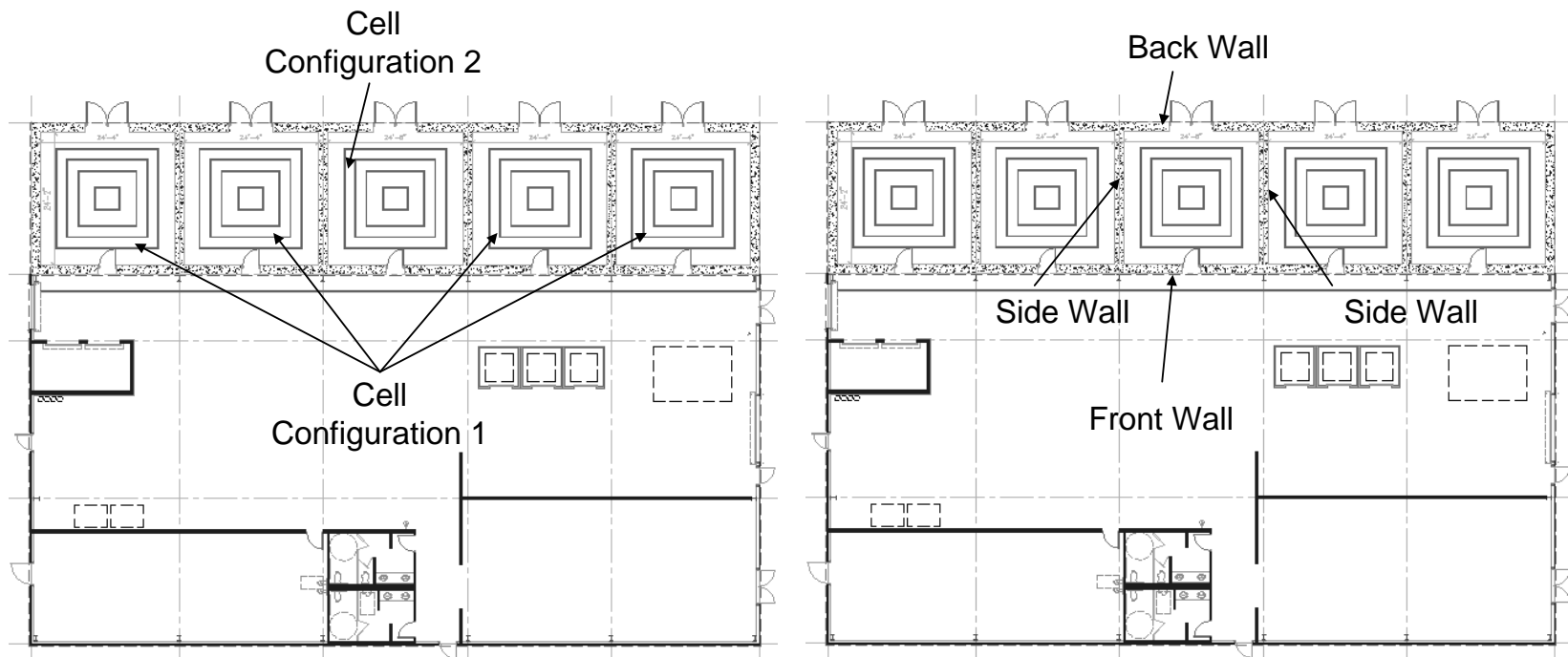
# Remote Test Cell Load Prediction

- Software
  - SHOCK
  - FRANG
- Operating Heights
  - 2 feet
  - 8 feet
  - 16 feet
- Reduced Blast Load Area

Design Basis Standoff	Reduced Area Function	Reduced Area Utilized
10 ft.	3 * Slab thickness	5 ft. x 5 ft.
7 ft.	3 * Slab thickness	5 ft. x 5 ft.
5 ft.	3 * Slab thickness	5 ft. x 5 ft.
3 ft.	Standoff	3 ft. x 3 ft.



# Remote Test Cell Predicted Response



## Test Cell Response

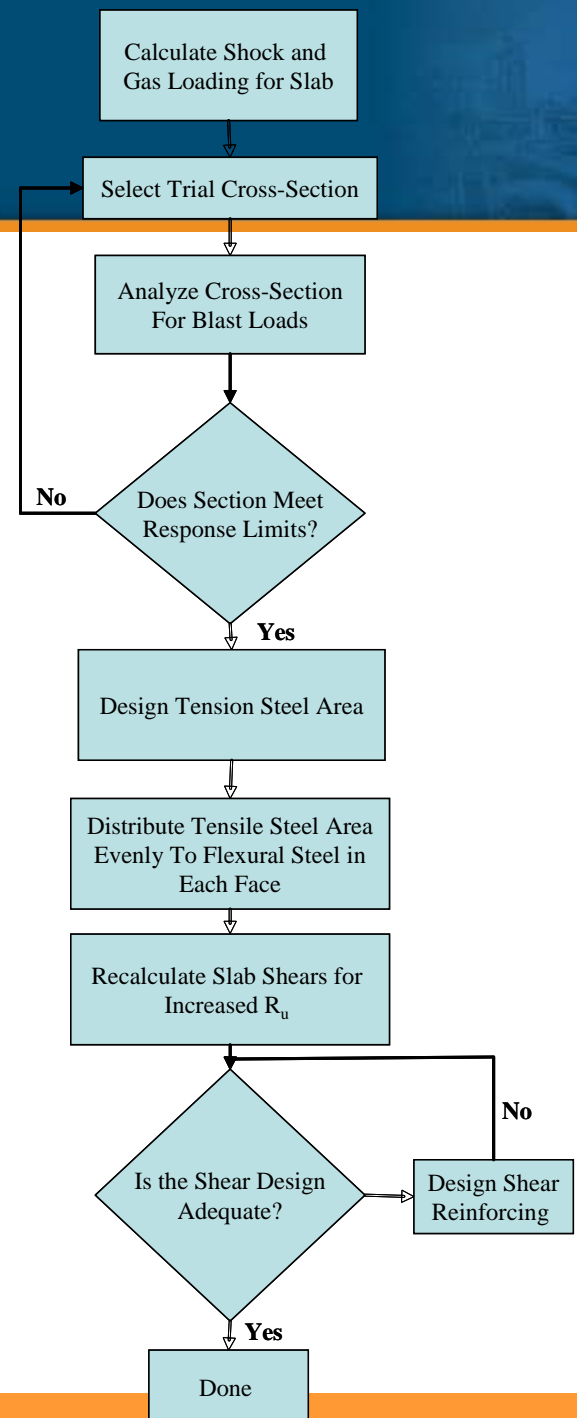
Component	Response Limits			Predicted Response		
	Ductility ( $\mu$ )	Rotation ( $\theta$ )	Deflection $\Delta_{\text{limit}}$	Ductility ( $\mu$ )	Rotation ( $\theta$ )	Deflection $\Delta_{\text{max}}$ (in)
Side Wall	-	2 deg.	5.0 in.	-	0.4 deg.	1.0 in.
Front Wall	-	2 deg.	2.9 in.	-	1.37 deg.	1.98 in.
Back Wall	-	2 deg.	3.0 in.	-	0.95 deg.	1.45 in.
Roof	-	2 deg.	5.0 in.	-	0.37 deg.	0.93 in.
Personnel Door	10	2 deg.	0.63 in.	0.6	1.0 deg.	0.32 in.

# Structural Design Assumptions

- Concrete strength –  $f'_c = 4,000$  psi
- Reinforcement strength –  $f_y = 60,000$  psi
- Concrete cover – 2 in. on each face
- Dynamic Increase Factor (DIF)
  - Concrete – Calculated based on strain rate
  - Reinforcing Steel – Calculated based on strain rate
  - Personnel Door – Calculated based on strain rate
- Response Criteria
  - Slabs – 2 degrees rotation - Category 1 response with stirrups
- Steel Blast Doors – 2 degrees rotation or a ductility of 10

# Structural Capacity

- Structural Capacity – Engineering Analysis
  - Flexural Response
  - Tension
  - Diagonal Tension Shear
  - Direct Shear
  - Factor of Safety for Design
    - 1.2 on N.E.W.





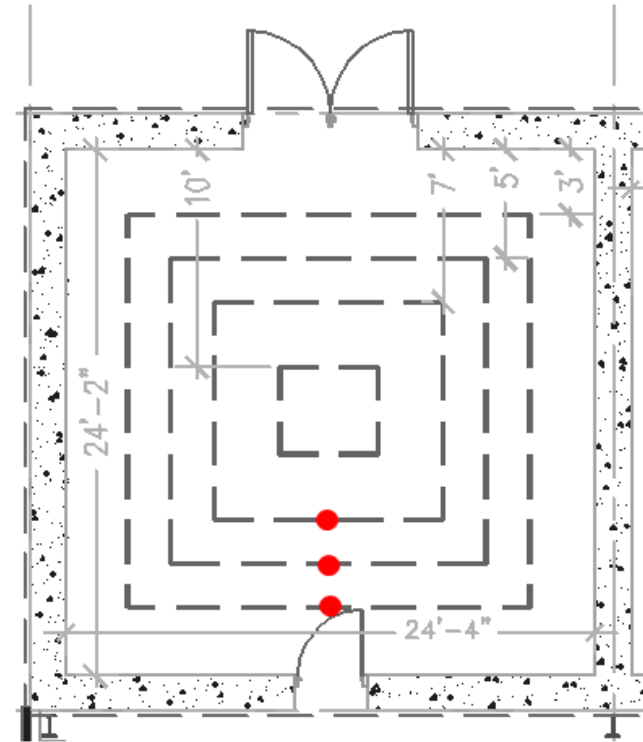
# Remote Test Cell Design Summary

- Thickness of cross-section is 20 inches, typical
- Minimum concrete compressive strength 4,000 psi
- Reinforcing
  - #5 bars, each face, each way (horizontal and vertical) at 8 inches on center
  - 2 inch concrete cover, both faces
  - #4 90-135 stirrups at 8 inches on center, each way.
  - #6 diagonal bars, no corner haunches
- The cubicle walls were securely attached at the floors and edges to adjoining slabs through development of reinforcement into the adjacent slabs. Adjacent slabs are capable of resisting the full supported moment.
- The walls must provide personnel protection from remote operations.

# Reduced Standoff Ratings

- Design Basis Requirements
  - Structural Response
  - Concrete Spalling
  - Scaled Distance –  $3 \text{ ft/lb}_{\text{TNT}}^{1/3}$

Minimum Required Standoff	Allowable Charge Weight - $\text{lb}_{\text{TNT}}$
7 feet	7.5
5 feet	3.9
3 feet	0.8



# Closure

- The objectives of the design of the China Lake Fuze Test Facility included:
  - Design Remote Test Cells to contain effects of accidental detonation
    - Net Explosive Weight =  $10 \text{ lb}_{\text{TNT}}$
    - Minimum Standoff = 10 feet
    - Reduced Standoffs of 7 feet, 5 feet and 3 feet were evaluated
  - Personnel Protection from accidental detonation Remote Test Cell for concurrent operations:
    - Overpressure below 2.3 psi
    - Thermal flux below  $0.3 \text{ cal/cm}^2/\text{sec}$
    - Hazardous fragment energy below  $58 \text{ ft} \cdot \text{lbf}$
- DDESB Approval Obtained and the Facility is Currently Under Construction

# Questions?

